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|            |   |      |            |
|------------|---|------|------------|
| <u>L18</u> | L17 and (silica and silicon)  | 6    | <u>L18</u> |
| <u>L17</u> | L16 and (tread or tire)   | 8    | <u>L17</u> |
| <u>L16</u> | L13 and (molecular adj weight)  | 11   | <u>L16</u> |
| <u>L15</u> | L13 and (polyisoprene adj molecular adj weight)   | 0    | <u>L15</u> |
| <u>L14</u> | L13 and (tread or tire)   | 8    | <u>L14</u> |
| <u>L13</u> | L12 and L1  | 11   | <u>L13</u> |
| <u>L12</u> | isoprene adj butadiene adj block adj copolymer  | 45   | <u>L12</u> |
| <u>L11</u> | L10 and (molecular adj weight)  | 33   | <u>L11</u> |
| <u>L10</u> | L9 and (tread or tire)  | 36   | <u>L10</u> |
| <u>L9</u>  | L1 and ((IR and BR) or (IR and SBR) or (IR and BR adj IR) or (IR and SBR and IR))   | 89   | <u>L9</u>  |
| <u>L8</u>  | (IR-BR) adj block adj copolymer   | 0    | <u>L8</u>  |
| <u>L7</u>  | L6 and L2   | 1    | <u>L7</u>  |
| <u>L6</u>  | L5 and (low adj molecular adj weight)   | 48   | <u>L6</u>  |
| <u>L5</u>  | polyisoprene adj block adj copolymer  | 228  | <u>L5</u>  |
| <u>L4</u>  | L2 and (isoprene adj endblock)  | 0    | <u>L4</u>  |
| <u>L3</u>  | L2 and (molecular adj weight adj polyisoprene)  | 5    | <u>L3</u>  |
| <u>L2</u>  | L1 and ((polyisoprene adj polybutadiene adj blocks adj copolymer) or (polyisoprene adj unsaturated adj diene adj elastomer) or (IR and BR) or (IR and SBR) or (polyisoprene and (styrene adj butadiene adj copolymer))) | 260  | <u>L2</u>  |
| <u>L1</u>  | (diblock adj copolymer) or (triblock adj copolymer)   | 3862 | <u>L1</u>  |

END OF SEARCH HISTORY

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L11: Entry 14 of 33

File: USPT

Aug 13, 1996

DOCUMENT-IDENTIFIER: US 5545783 A  
TITLE: Vulcanizable liquid compositions

Brief Summary Text (26):

wherein the block A is a block or random copolymer of about 30 to about 70%, preferably about 40 to about 60%, by mole of at least one aryl-substituted olefin, such as styrene, 2-phenyl alpha-olefins, alkylated styrene, vinyl naphthalene or alkylated vinyl naphthalene, and about 30 to about 70%, preferably about 40 to about 60%, by mole of at least one conjugated diene of formula (1), discussed above; D is a block of a polymer of at least one conjugated diene of formula (3), discussed above, which is different from the conjugated diene of formula (1) used to polymerize the block (A); x is about 2 to about 30%, preferably about 4 to about 16%, by wt., of the weight of the triblock copolymer, and y is about 40 to about 96%, preferably about 68 to about 92%, by wt., of the weight of the triblock copolymer. Examples of suitable conjugated dienes used to polymerize the A block are isoprene, 2,3-dimethyl butadiene, myrcene or 2-methyl-1,3-pentadiene. Suitable conjugated dienes used to polymerize the D block are 1,3-butadiene or 1,3-pentadiene.

Brief Summary Text (36):

In all embodiments of this invention, whenever a reference is made to the "residual double bond" of the block or random polymer (or copolymer), it is understood to be the residual double bond prior to the hydrogenation reaction. The structure of the residual double bond can be determined in any conventional manner, as is known to those skilled in the art, e.g., by infrared (IR) or NMR analysis.

Drawing Description Text (2):

FIG. 1 shows the relationship of viscosity as a function of molecular weight for the unhydrogenated isoprene - butadiene - isoprene triblock polymer of this invention.

Drawing Description Text (3):

FIG. 2 shows the relationship of viscosity as a function of molecular weight for the hydrogenated isoprene - butadiene - isoprene triblock polymer of this invention.

Drawing Description Text (4):

FIGS. 3 and 4 show properties of the cured selectively hydrogenated isoprene-butadiene-isoprene polymers of this invention as a function of molecular weight thereof.

Detailed Description Text (5):

Many variations in composition, molecular weight, molecular weight distribution, relative block lengths, microstructure, branching and Tg (glass transition temperature) attainable with the use of anionic techniques employed in the preparation of our polymers will be obvious to those skilled in the art.

Detailed Description Text (6):

While not wishing to limit the molecular weight range of liquid elastomers prepared according to our invention, the minimum molecular weight for these liquid polymers is at least about 2,000, preferably about 5,000 to about 15,000, and most preferably about 7,500 to about 10,000. Star-branched block and random polymers of this invention may have substantially higher molecular weights and still retain liquid properties. For example, liquid star-branched block polymers having molecular weight of about 34,000 have been prepared. The block copolymers of this invention are vulcanizable. Without wishing to be bound by any theory of operability, it is believed that they can be crosslinked (or vulcanized) in a controlled manner through the unsaturated groups on the terminal blocks to provide a very strong and orderly matrix of crosslinkages having

almost uniform distribution of molecular weights between crosslinks,  $M_{sub.c}$ . The random and star-branched copolymers of this invention are also vulcanizable. The designation  $M_{sub.c}$ , as used herein for the block copolymers means the length of the middle block. For random copolymers,  $M_{sub.c}$  is calculated by dividing number average molecular weight,  $M_{sub.n}$ , of the polymer by the average number of crosslinks per chain plus 1.

Detailed Description Text (13):

x is at least 1, preferably 1 to 15, more preferably 2 to 10, and most preferably 2 to 7, y is at least 25, preferably 90 to 300, more preferably 130 to 200, and most preferably 140 to 200. The above definition of x means that each of the I blocks is polymerized from at least 1, preferably from 1-15, more preferably from 2-10 and most preferably from 2-7 monomer units. For some special applications, each of the I blocks is polymerized from 20-30 monomer units. The block polymers containing such large I blocks have increased vulcanization rate, as compared to those containing smaller I blocks, and are co-vulcanizable with diene rubbers available in the art, e.g., polybutadiene and natural rubbers. The block polymers containing such large I blocks can be blended with diene rubbers by conventional methods and subsequently vulcanized to produce novel compositions of this invention. The resulting materials are expected to have increased oxidation and ozone degradation resistance as compared to known diene rubbers alone, and therefore are expected to be valuable materials for the production of white sidewalls of tires and similar articles.

Detailed Description Text (30):

Triblock Copolymer of Poly-Diene Center Block and Terminal Blocks of Aryl-Substituted Olefin/Diene Copolymer

Detailed Description Text (35):

In the most preferred embodiment, the block A of this triblock copolymer is polymerized from isoprene and styrene in the molar proportion of about 1:1. Most preferably, in this embodiment of the invention, the A block is polymerized from isoprene and styrene, and the D block from 1,3-butadiene, in such proportions that the final copolymer comprises about 1.5 to about 6% wt. of the isoprene, about 2.5 to about 10% wt. of the styrene, and about 84 to about 96% wt. of the butadiene units.

Detailed Description Text (38):

Triblock Copolymer of at Least One Poly-Diene Center Block, and at Least One Terminal Block of Aryl-Substituted Olefin/Diene Copolymer

Detailed Description Text (58):

The block and random copolymers of this invention can, of course, be blended with any unsaturated elastomers, in which case the degree of unsaturation of the copolymers of the invention can be adjusted so that the vulcanization rate of the two materials is substantially the same. Suitable elastomers which can be blended with the copolymers of this invention are liquid butyl, liquid polyisoprene, liquid polybutadiene (modified and unmodified), and liquid EPDM. Suitable solid rubbers with which the copolymers of this invention can be blended are, e.g., SBR, polyisoprene, polybutadiene, EPDM, butyl rubber and neoprene.

Detailed Description Text (61):

The block copolymers of this invention are polymerized by any known block polymerization processes, preferably by an anionic polymerization process. Anionic polymerization is well known in the art and it is utilized in the production of a variety of commercial polymers. An excellent comprehensive review of the anionic polymerization processes appears in the text ADVANCES IN POLYMER SCIENCE 56, ANIONIC POLYMERIZATION, pp. 1-90, Springer-Verlag, Berlin, Heidelberg, New York, Tokyo 1984 in a monograph entitled ANIONIC POLYMERIZATION OF NON-POLAR MONOMERS INVOLVING LITHIUM, by R. N. Young, R. P. Quirk and L. J. Fetters, incorporated herein by reference. The anionic polymerization process is conducted in the presence of a suitable anionic catalyst (also known as an initiator), such as n-butyl-lithium, sec-butyl-lithium, t-butyl-lithium, sodium naphthalide or cumyl potassium. The amount of the catalyst and the amount of the monomer in the polymerization reaction dictate the molecular weight of the polymer. The polymerization reaction is conducted in solution using an inert solvent as the polymerization medium, e.g., aliphatic hydrocarbons, such as hexane, cyclohexane or heptane, or aromatic solvents, such as benzene or toluene. In certain instances, inert polar solvents, such as tetrahydrofuran, can be used alone as a solvent, or in a mixture with a hydrocarbon solvent.

Detailed Description Text (64):

When the alkyl lithium-based initiator, a polar compound and an isoprene monomer are combined in an inert solvent, polymerization of the isoprene proceeds to produce the first terminal block whose molecular weight is determined by the ratio of the isoprene to the initiator. The "living" polyisoprenyl anion formed in this first step is utilized as the catalyst for further polymerization. At this time, butadiene monomer is introduced into the system and block polymerization of the second block proceeds, the presence of the polar compound now influencing the desired degree of branching (1,2-structure) in the polybutadiene block. The resulting product is a living diblock polymer having a terminal anion and a lithium counterion. The living diblock polymer serves as a catalyst for the growth of the final isoprene block, formed when isoprene monomer is again added to the reaction vessel to produce the final polymer block, resulting in the formation of the I-B-I triblock. Upon completion of polymerization, the living anion, now present at the terminus of the triblock, is destroyed by the addition of a proton donor, such as methyl alcohol or acetic acid. The polymerization reaction is usually conducted at a temperature of between 0.degree. C. and about 100.degree. C., although higher temperatures can be used. Control of a chosen reaction temperature is desirable since it can influence the effectiveness of the polar compound additive in controlling the polymer microstructure. The reaction temperature can be, for example, from 50.degree. to 80.degree. C. The reaction pressure is not critical and varies from atmospheric to about 100 psig.

Detailed Description Text (69):

The use of some of the coupling agents provides a convenient means of producing star-branched block and random polymers. The star-branched block polymers are made from any combination of blocks I and B, A and D or I, D and A, defined above, providing that each free end (i.e., the uncoupled end) of the star-branched polymer is either an I or an A block, respectively. The star-branched random polymers are made from any combination of at least one diene of formula (1) and at least one diene of formula (3), different from the diene of formula (1), or from at least one aryl-substituted olefin, at least one diene of formula (1) and at least one diene of formula (3), different from the diene of formula (1). The molecular weight of the star-branched block and random copolymers will depend on the number of branches in each such copolymer, as will be apparent to those skilled in the art. Suitable coupling agents and reactions are disclosed in the following references which are incorporated herein by reference: U.S. Pat. Nos. 3,949,020; 3,594,452; 3,598,887; 3,465,065; 3,078,254; 3,766,301; 3,632,682; 3,668,279; and Great Britain patents 1,014,999; 1,074,276; 1,121,978.

Detailed Description Text (83):

Upon completion of the hydrogenation process, unreacted hydrogen is either vented or consumed by the introduction of the appropriate amount of an unsaturated material, such as 1-hexene, which is converted to an inert hydrocarbon, e.g., hexane. Subsequently, the catalyst is removed from the resulting polymer solution by any suitable means, selected depending on the particular process and polymer. For a low molecular weight material, for example, catalyst residue removal may consist of a treatment of the solution with an oxidant, such as air, and subsequent treatment with ammonia and optionally methanol in amounts equal to the molar amount of the metals (i.e., the sum of the transition metal and the metal of the reducing agent) present in the hydrogenation catalyst to yield the catalyst residues as a filterable precipitate, which is filtered off. The solvent may then be removed by any conventional methods, such as vacuum stripping, to yield the product polymer as a clear, colorless fluid.

Detailed Description Text (85):

In yet another alternative method, the catalyst may be removed by extraction with an aqueous mineral acid, such as sulfuric, phosphoric or hydrochloric acid, followed by washing with distilled water. A small amount of a material commonly used as an aid in removing transition metal-based catalysts, such as a commercially available high molecular weight diamine, e.g., Jeffamine D-2000 from Texaco, may be added to aid in phase separation and catalyst removal during the extractions. The resultant polymer solution is then dried over a drying agent, such as magnesium sulfate, separated from the drying agent and the solvent is then separated by any conventional methods, such as vacuum stripping, to yield a polymer as a clear fluid. Other methods of polymer isolation, such as steam or alcohol flocculation, may be employed depending upon the hydrogenated polymer properties.

Detailed Description Text (87):

In addition to acting as sites for vulcanization, the unsaturated terminal blocks of the block polymers of this invention can be chemically modified to provide benefits obtained with similar modifications of existing commercial materials, such as butyl rubber or EPDM. In some instances, the benefits obtained by a chemical modification of

butyl rubber or EPDM may be magnified using the elastomers of our invention as a matrix instead of the butyl rubber or EPDM of similar molecular weight because of their intrinsically superior elastomeric properties.

Detailed Description Text (99):

Three hundred milliliters (ml) of purified, dried cyclohexane (99.5%, Phillips Petroleum) were introduced into a six-hundred milliliter stirred glass reactor. Air was removed from the reactor under vacuum and replaced by dry nitrogen. The reactor was equipped with an air driven stirrer, a pressure gauge, thermocouple, top surface inlet valve, dip tube feeder with valve, heating-mantle and variable controller and combination nitrogen/vacuum inlet with valve. Three ml of a 0.01M solution of bipyridyl in cyclohexane, 7.3 ml (90 mmol) of tetrahydrofuran freshly distilled from benzophenone ketyl and 1.8 ml (18 mmol) of purified isoprene were injected into the reactor. The temperature of the reactor and its contents was raised to 50.degree. C. The solution was then titrated by addition of 1.6M butyl lithium until a persistent red color was obtained. Following this, 3.75 ml of 1.6M butyl lithium was injected into the reactor in order to initiate polymerization of the isoprene. The reaction was allowed to run for one hour, after which 47.5 g of purified butadiene were pressured into the reactor at a rate such that the reaction temperature did not exceed 70.degree. C. After one hour, the reactor pressure had returned to its initial level and the formation of the second block of the copolymer was completed. Isoprene (1.8 ml, 18 mmol) was again injected into the reactor to allow for the formation of the third and final block of the triblock polymer. After one hour, 0.35 ml of acetic acid (4.5 mmol) were injected into the reactor to quench the triblock living anion. The color of the reaction mixture changed from a dark amber to colorless immediately. The mixture was cooled to room temperature, filtered through alumina/Celite, an anti-oxidant, Irganox 1076 from Ciba-Geigy (100 ppm based on dry polymer) was added and solvent was removed under reduced pressure to yield a triblock polymer of about 8400 molecular weight as a clear, colorless, viscous fluid. Infra-red analysis (Fourier Transform) showed the butadiene center block to possess 55% (1,2)- and 45% of (1,4)-microstructure.

Detailed Description Text (103):

1500 grams of purified, dried cyclohexane (99.5%, Phillips Petroleum) were introduced into a one gallon stirred stainless steel reactor. The reactor was equipped with a stirrer, pressure gauge, thermocouple, top surface inlet, dip tube feeder with valve, variably controlled heater and heat exchange coil. Following the addition of the solvent, 50 ml (0.614 mol) of tetrahydrofuran freshly distilled from benzophenone ketyl, 43.3 ml (0.433 mol) of purified isoprene and an additional 80 g of cyclohexane were pressured into the reactor. The temperature of the reactor and its contents was raised to 50.degree. C. Butyl lithium (61.2 ml of 1.5M solution, 91.8 mmol) was pressured into the reactor in order to titrate impurities and initiate polymerization of the isoprene. The reaction was allowed to run for one hour, after which 1100 ml of purified butadiene (12.65 mol) were pumped into the reactor at a rate such that the reaction temperature did not exceed 60.degree. C. Cooling water was passed through the heat exchanger during this process to aid in the control of temperature. The butadiene feed was complete within thirty minutes. One hour later, the formation of the second block of the copolymer was complete and isoprene (43.3 ml, 0.433 mol) in 50 g of cyclohexane was again pressured into the reactor to allow for the formation of the third and final block of the triblock polymer. After one hour, the reaction mixture was cooled and discharged into a vessel containing 5.2 ml of acetic acid (90.8 mmol) to quench the triblock living anion. The mixture was filtered through alumina/Celite, an anti-oxidant (100 ppm based on dry polymer) was added and the solvent was removed under reduced pressure to yield a triblock polymer of about 8200 molecular weight as a clear, colorless, viscous fluid. Infra-red analysis (Fourier Transform) showed the butadiene center block to possess 56% (1,2)- and 44% of (1,4)-microstructure.

Detailed Description Text (105):

(Viscosity as a Function of Molecular Weight)

Detailed Description Text (106):

This example illustrates the relationship between the molecular weight of the triblock polymers prepared in the manner substantially the same as that of Examples I and II and their resulting bulk viscosities.

Detailed Description Text (107):

As is apparent from the data of FIG. 1, a linear relationship exists between the molecular weight of the unhydrogenated isoprene-butadiene-isoprene polymers prepared as in Examples I and II and the log of their room temperature bulk viscosities as measured using a Brookfield Engineering LVT viscometer operating at, for example, 0.6 rpm with

spindle number 5.

Detailed Description Text (111):

1400 grams of purified, dried cyclohexane (99.5%, Phillips Petroleum) were introduced into a one gallon stirred stainless steel reactor. The reactor was equipped with a stirrer, pressure gauge, thermocouple, top surface inlet, dip tube feeder with valve, variably controlled heater and heat exchange coil. Following the addition of the solvent, 88 ml (1.08 mol) of tetrahydrofuran freshly distilled from benzophenone ketyl, 21.8 ml (0.218 mol) of purified isoprene, 41.5 ml of purified styrene (0.362 mol) and an additional 50 g of cyclohexane were pressured into the reactor. The temperature of the reactor and its contents was raised to 50.degree. C. Butyl lithium (47.0 ml of 1.6M solution, 75.2 mmol) was then pressured into the reactor in order to titrate impurities and initiate polymerization of the isoprene. The reaction was allowed to run for one hour, after which 800 ml of purified butadiene (9.20 mol) were pumped into the reactor at a rate such that the reaction temperature did not exceed 60.degree. C. Cooling water was passed through the heat exchanger during this process to aid in the control of temperature. The butadiene feed was complete within thirty minutes. One hour later, the formation of the second block of the copolymer was complete and a mixture of isoprene (21.8 ml, 0.218 mol) and styrene (41.5 ml, 0.362 mol) in 50 g of cyclohexane was again pressured into the reactor to allow for the formation of the third and final block of the triblock polymer. After one hour, the reaction mixture was cooled and discharged into a vessel containing 4.3 ml of acetic acid (75.2 mmol) to quench the triblock living anion. The mixture was filtered through alumina/Celite, an anti-oxidant (100 ppm based on dry polymer) was added and solvent was removed under reduced pressure to yield a triblock polymer of about 8000 molecular weight as a clear, colorless viscous fluid. Infra-red analysis (Fourier Transform) showed the butadiene center block to possess 57% (1,2)- and 43% (1,4)-microstructure.

Detailed Description Text (115):

800 ml of purified, dried cyclohexane (99.5%, Phillips Petroleum) were introduced into a two liter stirred glass reactor. The reactor was purged several times with dry nitrogen. The reactor was equipped with an air driven stirrer, a pressure gauge, thermocouple, top surface inlet valve, dip tube feeder with valve, heat exchange coil and nitrogen inlet with valve. 5 ml of a 0.01M solution of bipyridyl in cyclohexane and 16.1 ml (198 mmol) of tetrahydrofuran freshly distilled from benzophenone ketyl were injected into the reactor. The reactor contents were titrated with 1.0M butyl lithium to a persistent red endpoint. The temperature of the reactor and its contents was raised to 50.degree. C. and 8.3 ml of 1.6M butyl lithium (13.3 mmol) were added. A mixture of 13.3 ml of isoprene (0.133 mol) and 90.9 g of purified butadiene (1.68 mol) was then pressured into the reactor at a rate that allowed for maintaining a temperature of between 50.degree. and 60.degree. C. The feed was completed in about 20 minutes, after which the reaction was allowed to proceed for an additional hour. The contents were cooled and discharged into a vessel containing 0.53 ml of methanol (13 mmol) to quench the copolymer living anion. The color of the reaction mixture changed from a dark amber to colorless immediately. The mixture was filtered through alumina/Celite, an anti-oxidant (100 ppm based on dry polymer) was added and solvent was removed under reduced pressure to yield a random copolymer of about 7500 molecular weight as a clear, colorless, viscous fluid. Infra-red analysis (Fourier Transform) showed the butadiene portion to possess 60% (1,2)- and 40% (1,4)-microstructure. In general, the infra-red spectrum was essentially indistinguishable from that of the triblock material of Examples I and II.

Detailed Description Text (117):

(Low Molecular Weight Polybutadiene)

Detailed Description Text (118):

This example illustrates the preparation of a low molecular weight polybutadiene in a manner completely analogous to that of the random copolymer of Example V.

Detailed Description Text (119):

800 ml of purified, dried cyclohexane (99.5%, Phillips Petroleum) were introduced into a two liter stirred glass reactor. The reactor was purged several times with dry nitrogen. The reactor was equipped with an air driven stirrer, a pressure gauge, thermocouple, top surface inlet valve, dip tube feeder with valve, heat exchange coil and nitrogen inlet with valve. 5 ml of a 0.01M solution of bipyridyl in cyclohexane and 16.1 ml (198 mmol) of tetrahydrofuran freshly distilled from benzophenone ketyl were injected into the reactor. The reactor contents were titrated with 1.6M butyl lithium to a persistent red endpoint. The temperature of the reactor and its contents was raised to 50.degree. C. and 8.3 ml of 1.6M butyl lithium (13.3 mmol) were added.

Purified butadiene (100 g, 1.85 mol) was then pressured into the reactor at a rate that allowed for maintaining a temperature of between 50.degree. and 60.degree. C. The feed was complete in about 20 minutes, after which the reaction was allowed to proceed for an additional hour. The contents were cooled and discharged into a vessel containing 0.55 ml of methanol (13.5 mmol) to quench the polybutadienyl living anion. The color of the reaction mixture changed from a dark amber to colorless immediately. The mixture was filtered through alumina/Celite, an anti-oxidant (100 ppm based on dry polymer) was added and solvent was removed under reduced pressure to yield polybutadiene of about 7500 molecular weight as a clear, colorless, viscous fluid. Infra-red analysis (Fourier Transform) showed the polybutadiene to possess 45% (1,2)- and 55% (1,4)-microstructure. In general, the infra-red spectrum was essentially indistinguishable from that of the triblock material of Examples I and II.

Detailed Description Text (129):

(Viscosity as a Function of Molecular Weight of Hydrogenated Triblock Copolymer)

Detailed Description Text (130):

This example illustrates the relationship between the molecular weight of the selectively hydrogenated triblock polymers prepared in the manner of Example VIII and their resulting bulk viscosities.

Detailed Description Text (131):

As is apparent in FIG. 2, a monotonic increase in room temperature bulk viscosity is observed as the molecular weight of the selectively hydrogenated triblock polymers is increased. In all cases, a Brookfield Engineering LVT viscometer operating at, for example 0.6 rpm with spindle number 5 was used. Surprisingly, however, even at a molecular weight of ten thousand g/mol ( $M_n=M_w$ ) the bulk viscosity does not exceed one million centipoises.

Detailed Description Text (142):

This example illustrates the selective partial hydrogenation of a low molecular weight polybutadiene prepared as in Example VI.

Detailed Description Text (146):

This example illustrates the low temperature vulcanization (cure) of a selectively hydrogenated low molecular weight isoprene-butadiene-isoprene triblock polymer into a solid rubber using the quinone dioxime (GMF) cure.

Detailed Description Text (149):

(Rubber Properties as Function of Molecular Weight)

Detailed Description Text (150):

This example illustrates the relationship between selectively hydrogenated triblock polymer molecular weight and final cured rubber properties. The cure method as described in Example XIII was employed with the addition of silica as an inert filler at a level of 50 parts to cure triblock polymers of isoprene-butadiene-isoprene prepared in the manner substantially the same as that of Example VII. The results are summarized below and in FIG. 3.

Detailed Description Text (151):

As shown in FIG. 5, for the range of molecular weights examined (2,000 to 10,000 g/mol), a maximum percent elongation value of 180% at break was observed for the 7,500 molecular weight selectively hydrogenated triblock polymer. The 10,000 molecular weight material displayed a similar but slightly inferior value and the materials of lower molecular weight were clearly inferior with respect to cured properties. For comparison, the uncured triblock bulk viscosities are included in the data.

Detailed Description Text (154):

This example illustrates the relationship between selectively hydrogenated triblock polymer molecular weight and final cured rubber properties. The cure method as described in Example XIII was employed with the adjustment of the curative levels to the isoprene unsaturation levels for the appropriate molecular weight. The triblock polymers were made from isoprene-butadiene-isoprene in the manner substantially the same as that of Example VII. The results are summarized below and in FIG. 4.

Detailed Description Text (155):

As shown in FIG. 4, for the range of molecular weights examined (5,000 to 10,000 g/mol), a maximum percent elongation value of greater than 25% at break was observed for the materials above 7,500 molecular weight. The 10,000 molecular weight material

displayed slightly better elongation and the lower molecular weight polymers were clearly inferior with elongations at break of 100% and less.

Detailed Description Text (169):

This example illustrates the relationship between the degree of branching of selectively hydrogenated isoprene-butadiene-isoprene polymers with approximately the same distance between crosslinks, M.sub.c of 8500, and the molecular weight and final cured rubber properties. The cure method as described in Example XIII was employed. The branched materials cured significantly faster at the same curatives level to rubbers of somewhat superior performance. All three samples of this Example were prepared from the same mix recipe summarized below.

Detailed Description Paragraph Table (1):

|                            | <u>Triblock Molecular Weight</u> |       |        |               |
|----------------------------|----------------------------------|-------|--------|---------------|
|                            | 2000                             | 5000  | 6500   | 7500          |
| 10000 Bulk Viscosity (cps) | 8500                             | 54700 | 424000 | 745000 976000 |

Detailed Description Paragraph Table (3):

| <u>Mix Recipe: Parts</u>                             |  |
|--|--|
| <u>Triblock Polymer 100.0 GMF 14.4</u>               |  |
| N-Chlorosuccinimide 22.4 Zinc Oxide 10.0 Silica 50.0 | <u>Physical Properties: Molecular Weight 2,000 5,000 6,500 7,500 10,000 Bulk Viscosity (cps) 8,500 54,700 424,000 745,000 976,000 % Elongation 20 75 100 180 165</u> |

Detailed Description Paragraph Table (4):

| <u>Molecular Weight 5,000 6,500 7,500 10,000 Mix</u> |  |
|--|--|
| Recipe: Polymer 100.0 100.0 100.0 100.0              | <u>GMF 19.6 14.4 12.4 9.4 N-Chlorosuccinimide 25.2 22.4 19.4 14.6 Zinc Oxide 13.2 10.0 8.6 6.6 Physical Properties % Elongation 65 109 245 262</u> |

Detailed Description Paragraph Table (6):

| <u>Mix Recipe: Parts</u>                |  |
|---|--|
| <u>Triblock Polymer 100.0 GBIF 11.0</u> |  |
| N-Chlorosuccinimide 17.2 Zinc Oxide 7.6 | <u>Uncured Molecular Weight 8400 25500 34000 Cured Physical Properties Approximate M.sub.c 8400 8500 8500 % Elongation 202 201 266 Tensile (psi) 329 408 421 Shore A Hardness 64 62 58</u> |